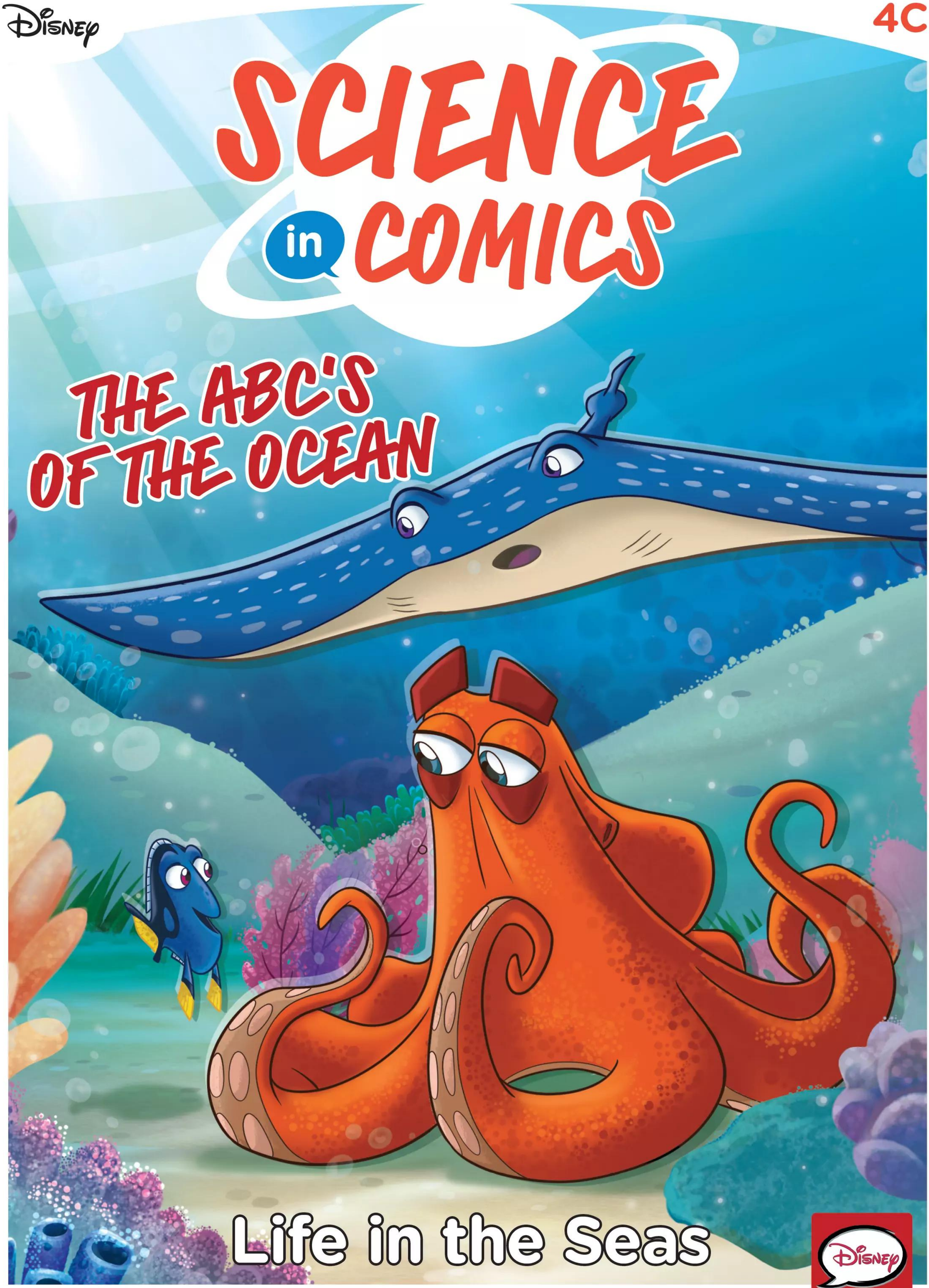
DISNEY

4C

SCIENCE in COMICS

THE ABC'S OF THE OCEAN



Life in the Seas

DISNEY COMICS

Disney **Science in Comics** is a series of comics titles designed to build a sound knowledge base for kids 8–12 years old, on science themes related to features and secrets of the world around us.

LIFE IN THE SEAS: *SAVING THE GREAT BARRIER REEF*

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THE SEARCH BEGINS!

Nemo, Dory, Hank, and Marlin are finally inside the Marine Life Institute...

Uh... I'm not sure this is the right way.

Maybe this place is too scary **for Nemo** at night.

Nope, I'm fine!

JELLYFISH JUNGLE

The jellyfish! Maybe they can help us find what we need!

Are you sure? Don't you remember when they stung you?

BOING

BOING

Hm, I don't remember it that way!

There are so many of them! Maybe Dory's right. We can ask them for help.

No, jellyfish can't talk.

But some of them **glow** in the dark!

And they don't have a heart, blood, bones, or a brain!

This board says that they're mainly made of water!

90% water

Wow!

JELLYFISH LIFE CICLE

1 The eggs and sperm cells are released into the water and join.

2 The larvae form.

The larvae settle on the bottom of the sea or on the rocks.

3

4 The larvae turn into polyps.

5 The polyps elongate and bud off the young jellyfish.

6 The young jellyfish grow into mature jellyfish.

Jellyfish have a very interesting life!

Jellyfish die.

Large quantities of dead jellyfish sink to the seabed.

The dead jellyfish turn into organic substances and make the seabed fertile*.

Lots of seagrass grows and becomes food for marine organisms.

They're also doing their part to make the ocean a healthier place.

Yeah, but they can only do that when they're dead...

True. But in that way they fertilize the seabed.

* If land (or the seabed, in this case) is fertile, it means it's rich in nutrients that help plants (or seagrass) grow and prosper.

Just then...

SWOOSH

=Gasp!= What's that?

What?

Shhh, if there's someone there, they won't see **us**.

They won't see **you**!

Huh, I guess you're right!

We'd better go before someone comes!

Not so fast, Hank!

SPLUSH

SPLISH

Yay, FASTER!

SWISH

science lab

Where are we going?

I don't know, but we're probably gonna get caught!

I just remembered that this is the lab we're lookin' for!

science

Hank, you're the best!

Ha! These doors are always open.

CLICK

CLICK
Here we are!
WOW!
What are all those tanks?

They're for the scientists' experiments. I'm gonna look for the corals now!

Yes!

Find them, Hank!

Hmm, no corals here.

Not here, either.

Hey! Go away!

Oh, no... what if we don't find the answers we're looking for?

Don't worry, Nemo. We'll keep searching.

Oh, maybe Miss Oyster can help us?

Hello there! Who are you? What do you need?

Hold on! I'm coming in!

What?!

SPLOSH

Dory?!

So... corals are bleaching, and... and the water is more...

It's more acidic. Currents are changing, and--

Oh, yeah. I've heard about all that.

How?

Really?

Sure! I spend all my days with the scientists. I hear everything they say.

Of course!

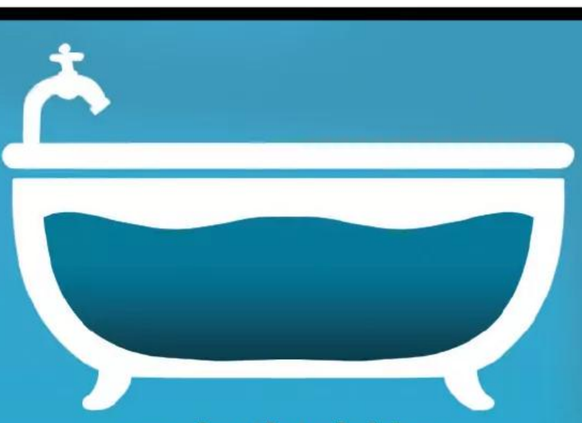
That water's really dirty! Why do they keep it here?

It's an experiment to show the important role of oysters in the sea.

"We oysters can **filter** water! While we eat, we pump a lot of water through our bodies and **hold on to** algae and other substances, which are our food."

One oyster

filters up to



one bathtub/day.

500.000 oysters

filter up to

36 Olympic swimming pools/day.

"So we make the water **cleaner** for seagrass and other marine organisms. The more of us there are, the better!"

But... if you filter water... can't you filter plastic, too?

No, unfortunately we can't!

That's a shame! That would've been really helpful.

Yeah, it could've solved a lot of problems!

I'm sorry... but it's impossible for us.

Well, you already do a lot to keep the ocean clean!

Yeah, I'm gonna thank every oyster I meet from now on.

Me too!

Maybe you know where we can find out more about all those problems?

Hmmm, let me think...

Please, it's really important. The ocean is in danger!

Sharkbait? Is that really you?

Sharkbait?!

I only know one fish who calls me that...

CONTINUES ON PAGE 133

PRECIOUS ANIMALS

- Much more than jellies
- Amazing creatures
- Filters . . . and much more!

Much more than jellies

STINGING TYPES

In the oceans, there are some creatures with extraordinary characteristics that we still know little about, like **jellyfish**. There are **thousands of different species** of jellyfish: some are very small, while others can grow up to three meters! What's more, their body has a gelatinous consistency and is **more than 90% water**. Despite a rather harmless appearance, when touched, special organs in their body produce little needles that inject **stinging substances** that can irritate the skin of other organisms. In some cases, they can cause a very serious allergic reaction and even paralysis. In this way, they not only **defend themselves** from predators but also **get food**: they paralyze their prey, then eat them.

Cyanea capillata, or the lion's mane jellyfish, is one of the largest in the world. It lives in the cold waters of the Arctic and the North Sea.

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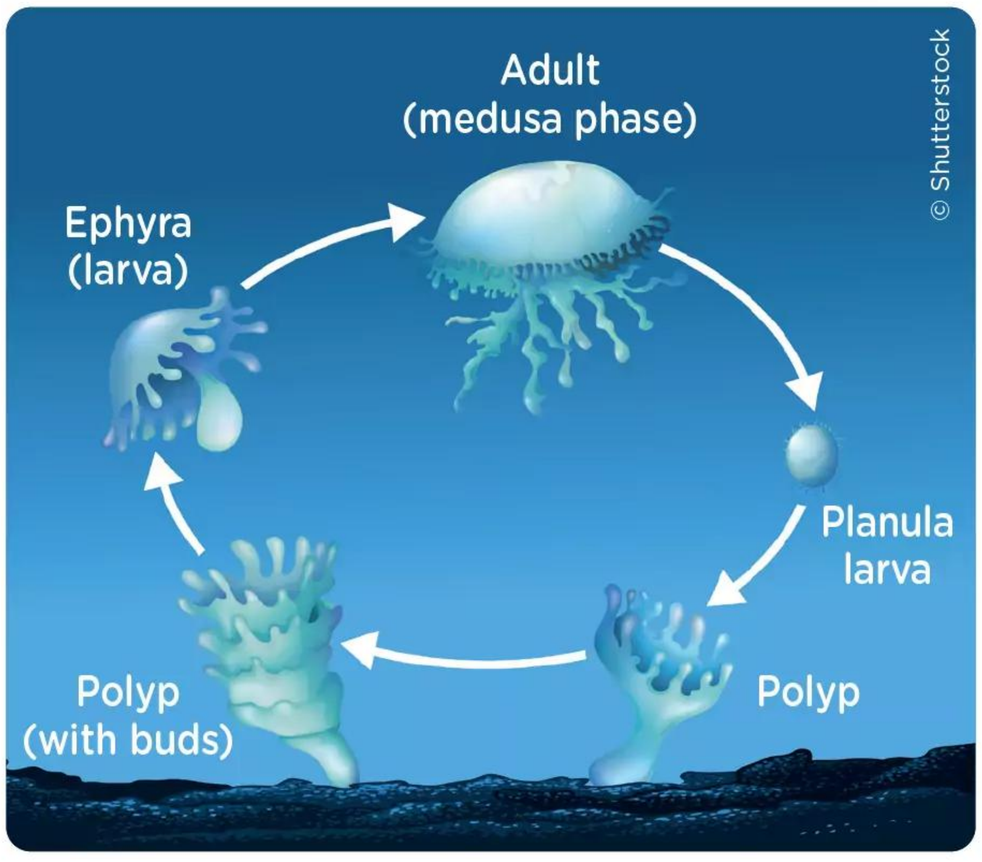
Amazing creatures

THE JELLYFISH LIFE CYCLE

The different phases of the life of an organism constitute its **life cycle**. In its first phase, a jellyfish is a **larva**, **called planula**, and is part of the plankton drifting along with the currents. The second phase begins when it comes across a suitable seabed, like rocks, to which the planula attaches and becomes part of the benthos, **transforming into a polyp**, like those of corals. At this stage, another type of larva, the **ephyra**, develops from the polyp, **breaks off**, and drifts along like the planulae. Over time, the ephyra becomes an adult jellyfish, and when a male and a female jellyfish generate new planulae, the cycle starts again!



During its life cycle, a jellyfish takes on different forms and lives in different places in the ocean: in the water column or attached to the seabed.

SPECIAL ABILITIES

Jellyfish have some special characteristics. For a start, around half of the species are **bioluminescent**, or capable of **producing light**. Jellyfish use this ability to defend themselves from predators, scaring them off with **flashes of light**. They can also **confuse them** with glowing tentacles that then break off, so the jellyfish can escape from the predators' grasp—a clever way of solving problems, especially for brainless organisms! Jellyfish don't actually have a real brain, but an organ that allows them to keep track of their location and react to light. There's even a very small jellyfish, *Turritopsis dohrnii*, that can **revert back** to an earlier life phase when in trouble, to better face the new circumstances. That's why it's also known as the **immortal jellyfish**.

***Aurelia aurita*, or moon jelly, is one of the bioluminescent species and lives in all the seas of the northern hemisphere.**

OCEAN SENTINELS

Jellyfish are essential for the ocean food chain since many other marine organisms feed on them. Some animals eat jellyfish even when they are dead. When they die, jellyfish fall to the bottom of the sea and form expanses called **jelly-falls**, becoming food for benthic organisms, as well as **fertilizing the seabed**. Therefore, Jellyfish are very important for ocean ecosystems. But that is true only

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Jellyfish are a very important food source for young sea turtles, in particular.

as long as there aren't **too many of them**. An overpopulation may happen very easily when predator numbers decrease, for example due to human actions like overfishing, creating an **imbalance in the ecosystem** where jellyfish occupy the space of other species. That's why the presence and number of jellyfish enable scientists to assess the health and balance of the ocean ecosystems.

Filters . . . and much more!

OYSTERS

Another very valuable organism for the ocean's well-being is the oyster. There are **about 150 species** of oyster, spread across of the world. They are **bivalve mollusks**, meaning they're enclosed in a shell made up of two parts, called valves. At the start of their lives, their larvae drift along in the plankton. Then, when they find a suitable seabed solid surface, they settle there and develop into adult oysters. One particular characteristic is that **they can change sex**, from male to female and vice versa, to maintain the correct balance for reproduction. And when something annoying or dangerous enters their shell, such as a pebble, **they cover it with a hard white substance** to defend themselves. This is how **pearls** are formed.

Pearls are made up of calcium carbonate, which is deposited around whatever enters the shell in order to isolate the dirt and keep the oyster clean.

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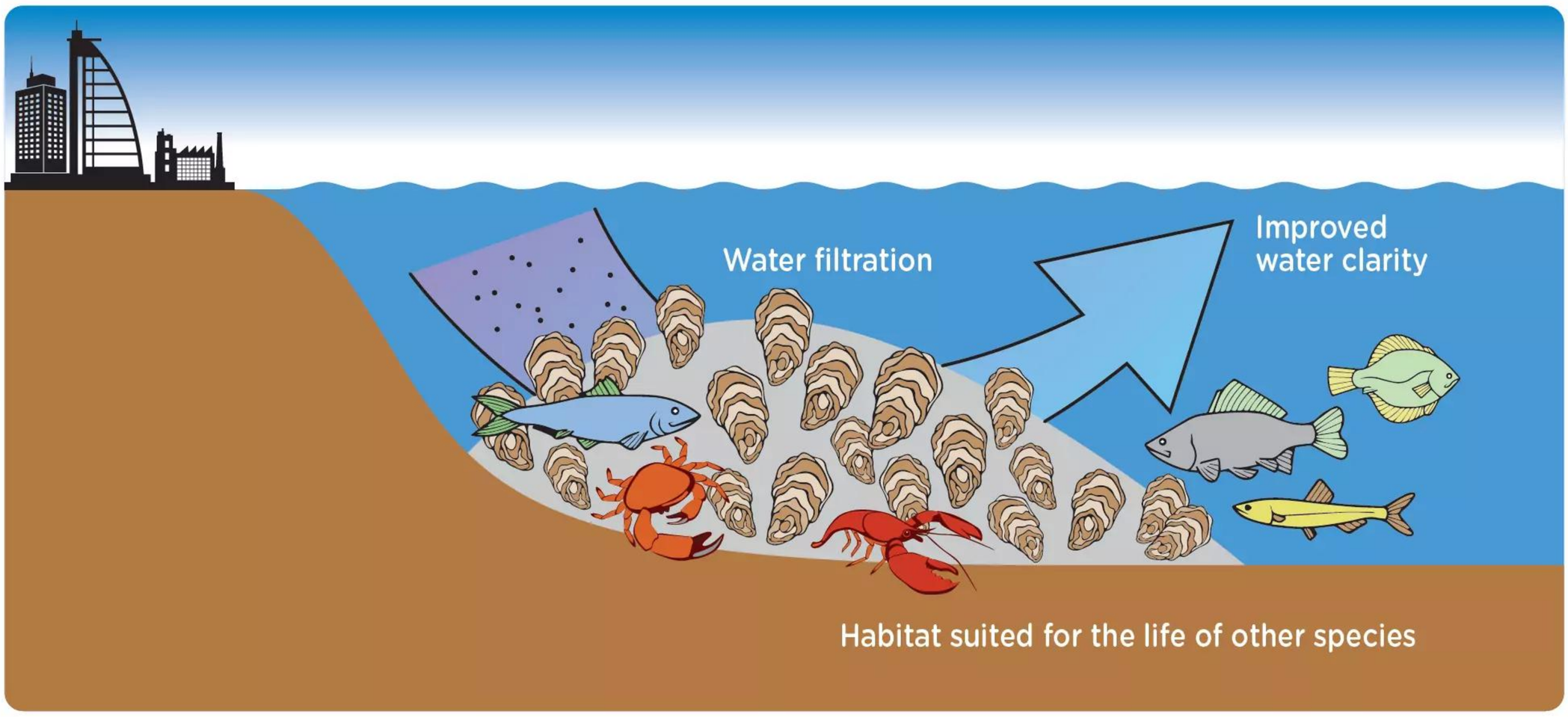
OCEAN FILTERS

Oysters are the **sea's natural filters**. Water enters their shells dirty and comes out clean. While sucking in sea water to eat the algae and other small organisms in it, these mollusks hold back harmful substances and finally expel the clean water. In this way, an oyster is able to filter, or clean up, **up to 150 liters of water a day**! Thanks to this extraordinary ability, millions of oysters have been used since 2008 to **clean up New York Harbor** in the United States. In short, they act as real "garbage cleaners" of the marine ecosystem.

With their filtering action, oysters keep ocean water clear and a suitable habitat for other organisms such as fish and crustaceans.



OYSTER REEFS

Another beneficial effect of oyster colonies is the protection they provide for the coastline. They grow one on top of another, in layers, with their shells forming **reefs**, or structures that resemble rocks. This creates natural barriers that protect the coasts from erosion. Oyster reefs are also **the habitat of numerous organisms**, such as mussels, anemones, crabs, and barnacles. And the shell reefs can become a **refuge and habitat for small fish** that are important for the human diet, such as anchovies, sole, and herring. Oysters themselves can also be eaten, and in various parts of the world, the oyster trade is a very important activity important for the local economy.

The protection provided by oyster reefs is very important for sandy coastlines, which are easily eroded by the sea.

BIG REVEALS

Where are you?!

Who's Nemo talking to?

I don't know!

We're over here, Sharkbait!

Hank, can you take me there?

Okay, kid!

Wait for me! I wanna see, too! Bye, Miss Oyster!

SPLOSH

Thanks for your visit!

Here we go!

Where?

Don't worry, Dad.

TRRR

Yeesh, you all are getting heavy!

FRUSH

Nemo! It's *très* good to see you, monsieur!

I can't believe you're here, little fella!

Wow! I knew it was you! It's so great to see you!

Uh... who are they?

They're my friends from the dentist's office in Sydney!

Wow!

DIDN'T BRUSH!

Yeah... but we escaped, and some humans found us and brought us here.

Exactement!

So what are **you** doing here?

Well, we're looking for some important answers.

There are **lots of problems** in the ocean.

Have you heard the scientists talk about plastic, climate change, acidic waters, or coral bleaching?

I think I saw a video about that, honey!

Um... yeah. I remember that.

Mais oui. They show it lots of times.

Wow! That's exciting!

Where can we watch it?

You just need to switch on that whiteboard over there.

It's that white screen! I learned about that when I was here.

You just need to push the red button to switch it on, honey!

Buttons? How can we push the buttons?

With seven tentacles, that's gonna be a piece of... seaweed!

Go, Hank, go!

Urgh! Just a minute... =oof= I'm slipping down!

SWOSH

SWISH

Didn't he say it would be as easy as a "piece of seaweed"?

Ouch!

Ummm... Maybe I can help!

PONK

What are you doing?!

SPLASH

SWOOSH

SPLAT

SPLOOOSH

Yay!

Well done, Nemo!

TRRR

The Ocean Today

This research considers some of the problems the oceans have today...

Way to go, Sharkbait!

That's my boy! You did it! You're no longer a little fish!

Wow, look at all that trash!

Shh, just listen!

The ocean is polluted. What are the causes?

Human activity.

Factories often release polluting substances into the sea, while **ships** lose trash and fuel residues* during their journeys.

Last but not least, **people** produce a lot of trash daily. Plastic bottles, plates and cutlery, diapers, and other items often end up in the environment and then **in the sea**.

*Fuel Residues: a small amount of fuel that remains after the main part has been used.

So... the ocean is in danger because of **humans**?

We should've known!

Most trash takes many years to **decompose**.

FISH HOOK
600 YEARS

DIAPER
450 YEARS

CARDBOARD
2 MONTHS

PLASTIC BOTTLE
450–1,000 YEARS

PLASTIC CUTLERY
100–1,000 YEARS

DRINK CAN
200 YEARS

TOILET ROLL
1 MONTH

PLASTIC BAG
10–20 YEARS

GLASS
4,000 YEARS

This makes the ocean very polluted and dangerous for marine organisms.

Microplastics may remain in the sea forever.

That's terrible!

CLIMATE CHANGE = OCEAN CHANGE

Also, the Earth's temperature is rising... **mainly because of human activities.**

This change affects life in both the Great Barrier Reef and the ocean as a whole.

Shells are becoming thinner, some seaweed forests are disappearing, and the warmer temperature is having an impact on the currents and sea level, too. The ice is melting, and some flat islands are being submerged.

Burning fossil fuels

Producing industrial products

Raising livestock

Fertilizing crops

Cutting trees

Warmer water

Sea level rise

Changes in ocean currents

CO_2

Ocean acidification

The friends we met on the way were having the same problems!

Keep watching. A good part is coming up!

To preserve ocean life, despite acidification and warmer temperatures, Marine Life Institute experts are creating **Marine Protected Areas.**

These are areas of the ocean where human activities and navigation are **regulated, to protect** the habitats and living organisms. As a consequence, in the MPAs there's a wider variety of marine creatures.

UNPROTECTED AREA

MARINE PROTECTED AREA

Some environmental organizations are also using **big cleanup ships** to collect the plastic floating on the ocean surface.

Wow! These humans are trying to help us!

That's amazing!

Well, at least some of them are trying to make it right.

It will take a long time, but it's a good step toward a **cleaner and safer ocean.**

But...

BEEP

What?

Oh, no! We didn't get to hear about the coral bleaching!

I didn't realize it was so late.

Yeah, it always goes dark around this time.

I'm sorry.

Now what? We'll never find the answers we're looking for! What will we do?

Don't worry, Nemo. I think we're on the right track.

I heard the scientists talking about some **coral experiments**.

Where can we find them?

In the labs near the **quarantine area**!

I remember that place! Let's go, Hank!

Thank you! You're the best friends ever!

CONTINUES ON PAGE 147

PROTECTING THE OCEAN

- At the service of the planet!
- Someone to save
- Get inspired by nature
- What can humans do?

At the service of the planet!

ECOSYSTEM SERVICES

A healthy ocean with its resources has many important benefits for humans and life on the planet. Marine plants, macro- and microalgae, provide **more than half of the oxygen** on Earth and are one of the key components at the base of the **food chain**. Also, oceans **regulate the climate** through currents, and many **resources and raw materials** come from the sea—first of all, clean water. These benefits are called **ecosystem services**, and they are effective only if marine ecosystems are healthy. That's why it's important to protect those in danger, and one way of doing this is to create **Marine Protected Areas**, or MPAs. These are areas of the sea where habitats and their biodiversity are protected from intensive human action.

The pleasure of enjoying a clean sea for sport and leisure activities is another important service that the ocean ecosystem offers humans.

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Someone to save

A SAFE PLACE

Marine Protected Areas are specific zones of the ocean or the sea that humans decide to **protect** by restricting and regulating activities such as fishing and navigation. MPAs are created in **areas of particular importance** for the well-being of a specific marine species—for example, **oyster reefs and seagrass meadows**, which are both formidable barriers against coastal erosion and very important ocean habitats—or where ecosystems are **threatened** by pollution and unregulated human activities, such as careless tourism that jeopardizes the environment.

The marine reserve at Stony Point Bay in South Africa protects the penguins and seabirds that live in that area.

PROTECTED AREAS

Marine Protected Areas aren't all the same. **Different rules and restrictions** apply regarding the number of tourists who can access them or the types of buildings that can be built within them. In different areas there can be restrictions on fishing, **sailing**, and **diving**, as well as on the **extraction of minerals or gases** from the seabed. In many MPAs such restrictions are organized according to the zoning method, or the division of the area into zones with varying levels of control. There are usually three zones. The first zone is open to everyone, and people can also fish there if they follow some rules. The second is open only to some authorized tourists, and only scientists can enter the third zone to do research.

An example of Marine Protected Areas zoning in Sardinia, Italy: in the blue zone, people can fish with small boats; in the yellow one, swimming and diving are allowed; in the red one, only scientists are permitted.

Get inspired by nature

ECOSYSTEM ENGINEERS

Observing nature can often give us clues about what we need to do to protect it. Some species are capable of creating, maintaining, or modifying a habitat. That's why they're called **ecosystem engineers**. For example, some marine plants create submerged meadows by growing together, and corals form coral reefs. As we have seen, these habitats are **all rich in biodiversity** and therefore particularly important and in need of careful protection. By observing such species and thoughroughly studying them through **ecology**—the science that studies ecosystems—it's possible to understand how to restore damaged habitats, such as regrowing sea meadows.

A scientist places a study tool in a *Posidonia oceanica* meadow in the Kas-Kekova Marine Protected Area in Turkey.

UNDERWATER ROOTS

Scientists use the shapes of mangrove roots as inspiration to develop artificial barriers to protect coasts from erosion.

One very important ocean habitat is **mangrove forests**. Mangroves are plants found along the coasts of tropical countries that are actually very special, since their **roots grow in seawater**. They're so thick and intertwined that they slow down the flow of the water, retaining sand and pebbles from the seabed. This creates **a swampy environment**, where fish, crustaceans, and other organisms find refuge and food. That's why mangrove forests are also **a safe environment** for the larvae and young of various marine species.

THE IMPORTANCE OF MANGROVES

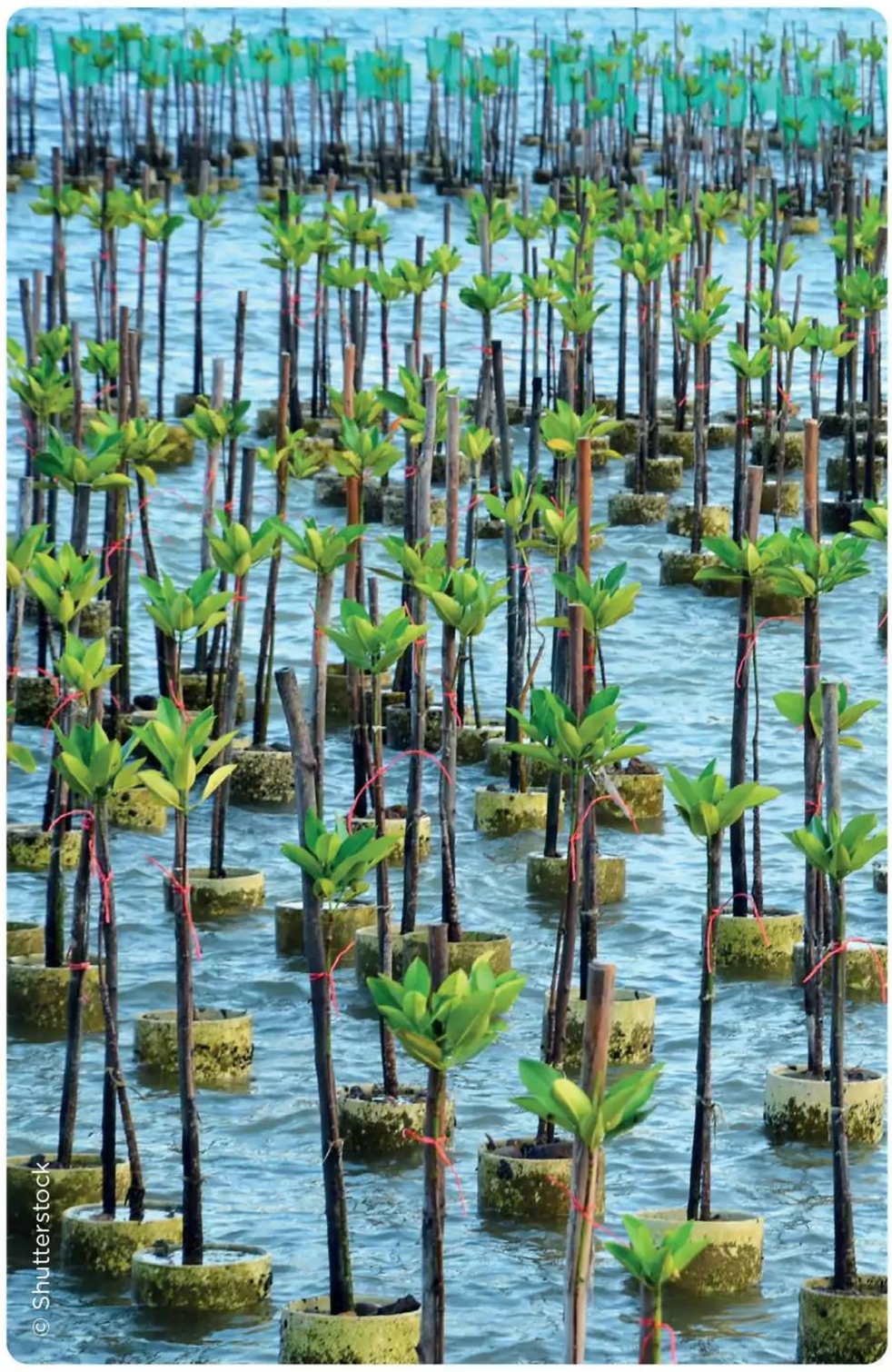
Mangrove forests create a thick natural barrier along the coast that **slows down erosion** and protects the environment and local communities from hurricanes and floodings. Their intricate system of roots and the ecosystem that is formed in that way is a safe place where many **marine species can live and reproduce**. Such abundance of species means locals can fish without affecting the total number of fish in the area and in the open sea close by, because the fish population is balanced by a large reproduction in the mangrove forests. These plants are also very efficient in **retaining excess carbon dioxide** they absorb from the atmosphere. Thus they reduce the amount of this gas and in turn climate change, which is directly affected by it.

All these ecosystem services provided by mangrove forests make them very important for the whole wider ocean ecosystem, but unfortunately, in many parts of the world, such as south-east Asia and South America, people destroy them to make room for huge, profitable shrimp farms. Once mangrove forests are destroyed, it's very difficult to make them grow back.

What can humans do?

IT'S TIME TO PUT THINGS RIGHT!

The well-being of ocean ecosystems is very important for humans. This is why scientists are constantly looking for different solutions to reduce damage to and uncontrolled exploitation of the marine environment. In addition to the **increase of Marine Protected Areas**, another solution is to make attempts **to "cure" damaged habitats**, as done when repairing bleached coral reefs. It's also important to use **sustainable**—that is, environmentally friendly—**means of navigation**, like boats and ships with more efficient and less polluting engines, and **to avoid dumping pollutants** into the sea. Last but not least, being mindful of reducing single-use plastics is also extremely helpful, as well as making an effort to rid the seas of the waste already there.



New mangrove seedlings are planted and cared for by scientists to repopulate damaged forests.

AMAZING EXPERIMENTS

Hey, look at those tanks! They might be the experiments!

No, Nemo. I don't think so...

I'll go check.

• two avocado toasts
• 1 pizza
• 1 grilled cheese sandwich

Yes! Look! There's... um ... something here.

Wait! I can read it. "Av... avo... cado toasts... One pizza..."

Gasp! They're doing experiments with food?

Maybe this room has become a kitchen.

No way! Let's see...

Oh, no! What's that?

I hope it's not a **tuna** sandwich!

SWISH

Could be. This is their lunch order! Let's check the next page.

Lunch is on its way!

What've we got here? "C... cau-s-es of... co-coral bleaching!"

Better than sandwiches, but we know the causes already.

CAUSES OF CORAL BLEACHING:

OCEAN TEMPERATURES RISING

POLLUTION

OCEAN ACIDIFICATION ↑CO_2

We need the way to fix it!

FLAP

"Pos-s... possi-ble so-lu-tion..."

What are they doing?

POSSIBLE SOLUTION
→ BUILD ARTIFICIAL BARRIERS...

Building an **underwater** barrier with huge rocks.

A rock barrier? Why?

I don't know, maybe...

Because they want to build a house for the corals!

Yeah, something like that... Check out this photo here!

...SO NEW CORALS CAN GROW ON THEM

It looks like a brand-new coral reef.

WOW! It does!

Great! We'll go back home and build a huge barrier!

Yeah! We'll save the corals!

Uhh...

We're fish! We can't build rock walls!

Yeah, Marlin's right.

Well, then what can we do? We need to save the corals!

Don't worry, Nemo. The **humans** seem to be working on it.

Yes, but there has to be something else **we** can do!

Let's look for another coral experiment!

There's just this **hermit crab** here...

Hey! I might be a hermit crab, but I know a lot about coral experiments.

What?

Really? Can you tell us? Please!

Please, please, please, Mr. Hermit Crab!

Well, if that stops you from bothering me, then I'll tell you. And then you can leave.

I've been here for some weeks. Acidic water is ruining my shell, ya know?

Yeah, we've learned about your problem.

I hope the humans find a way to solve it.

I've seen them studying new ways to **pollute less**. If I show you something, will you leave me alone?

Where are we going?

I don't know.

CORALS FROM THE GREAT BARRIER REEF -- AUSTRALIA
BLEACHED CORAL
HEALTHY CORAL
"Corals from the Great Barrier Reef -- Australia"? Hey! That's where we came from!
This is the coral transplanting lab.
Coral transplanting?
What's that?
It's a possible solution to coral bleaching and damaged reefs. I've seen scientists working on all the steps.

Can you tell us about them, please?

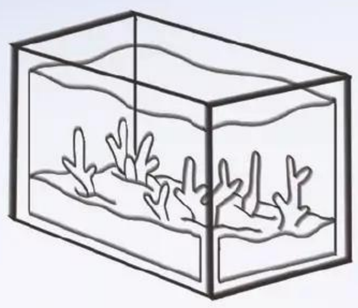
Fine. Take a look at the board up on the wall.

"The scientists go underwater and collect small coral branches, which are made of living polyps."

"Then, they take them to the lab and grow them in a tank."

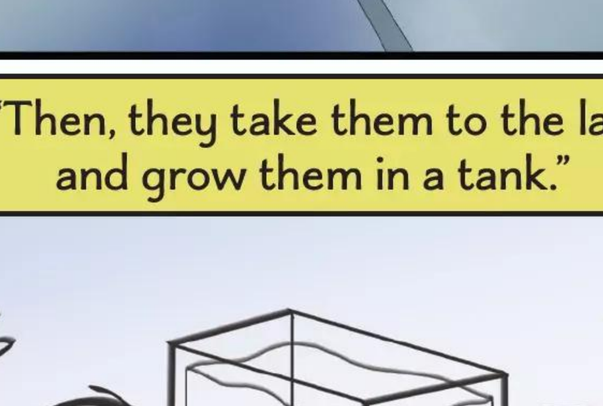
"When the polyp branches are ready, the scientists go back underwater..."

THE SCIENTISTS COLLECT HEALTHY CORAL BRANCHES.



THEY GROW THEM IN A TANK.

THEY TRANSPLANT THEM CLOSE TO BLEACHED OR DAMAGED CORAL...



... TO MAKE NEW CORAL GROW

"...and attach them to the bleached and damaged coral so they can start growing again."

Maybe scuba divers aren't always bad.

Yeah, maybe they were doing some good and collecting coral branches!

I like this solution!

We can do it in the Great Barrier Reef!

How long will it take to see the results?

Well, this experiment started...

... more than **nine years** ago.

Nine years?! That's a really long time!

Can we take some of **those** branches?

Yeah, since they're ready maybe it won't take so long.

Hmmm... that could probably work.

Take some of the smaller branches. I'm sure the coral won't mind.

Oh, thank you, Mr. Hermit Crab!

You're comin' with us, kids!

Go, Hank!

Careful, Hank. They're very delicate!

Easy does it!

Now you got what you needed. Go on and get outta here so I can have some peace and quiet again.

Make room, guys.

I can't believe we found a way to fix the coral bleaching and damage!

Welcome, little ones!

SPLASH

And...

Good luck! I guess you're doing a pretty good thing there!

Thank you!

Good luck to you, too!

CONTINUES ON PAGE 161

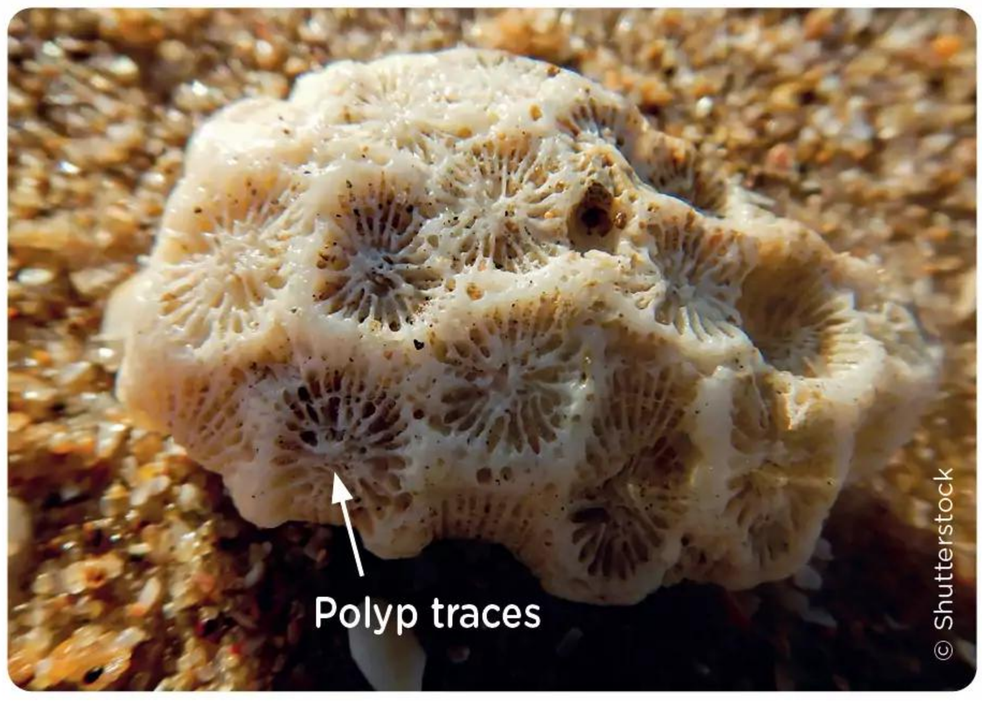
SAVING THE CORAL REEFS

- Corals: large communities
- A growing reef
- What threatens corals?
- Coral transplanting

Corals: large communities

THE CORALS' "CEMENT"

Coral reefs are one of the most spectacular habitats in the ocean, with each reef made up of colonies of small polyps joined together. They stay attached to each other and also to the seabed all thanks to **calcium carbonate**, the substance polyps deposit around themselves with the help of **zooxanthellae algae** that live inside the polyps. Calcium carbonate builds up the corals' skeleton and forms the structure of the coral reef.

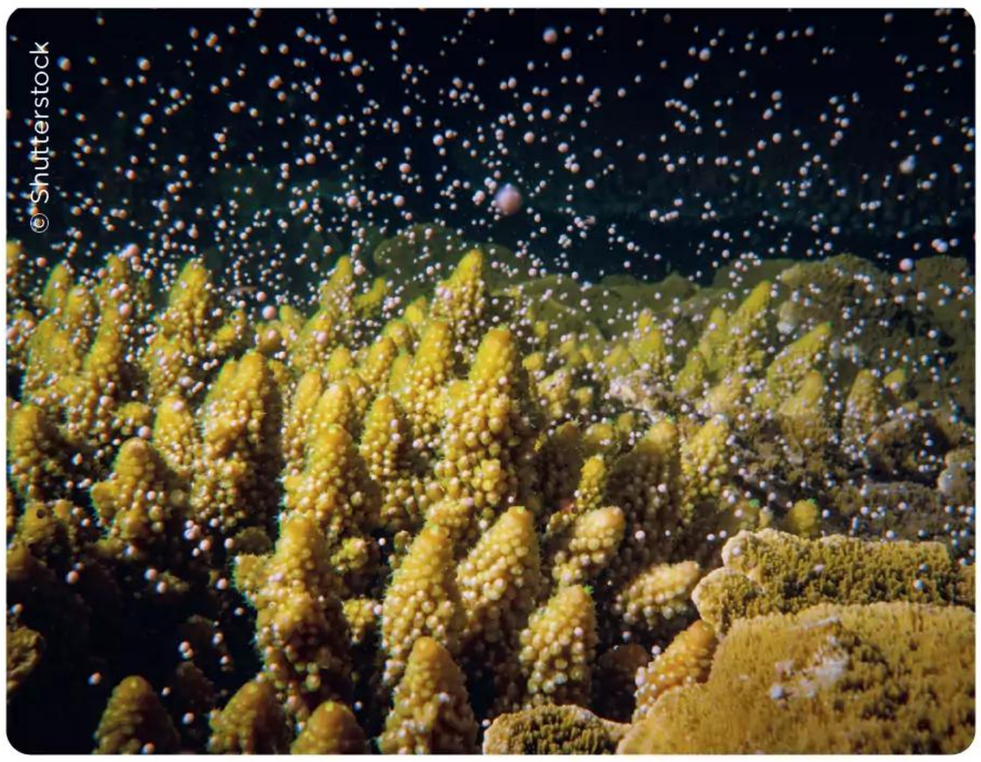


A fragment of coral reef. The traces of where the polyps lived, next to each other, can be seen in the star-shaped furrows in the calcium carbonate skeleton.

A growing reef

HOW ARE CORALS FORMED?

Coral reefs get bigger because the polyps reproduce, and they do that in many different ways. For instance, corals may give birth to new ones through **asexual reproduction**, which is when an organism divides and generates a new, identical one autonomously. Sometimes a little piece of coral breaks off, and when it settles on the seabed it starts growing again. In this case, we say it reproduces by **fragmentation**, that is, from a detached coral fragment. Corals can also reproduce by **sexual reproduction**: the male polyps release "seeds" called **sperms** into the sea, while the female polyps produce **eggs**. When the sperms and eggs join, the resulting fertilized eggs then develop into planulae, or larvae. Finally, when the planulae grow, they turn into polyps that settle on the seabed, forming new corals.



In many coral species, the polyps release the eggs and sperms all together, at the same time, to increase the chances of reproduction. This phenomenon is called mass spawning.

NEW ACCOMMODATION!

Coral reefs are delicate habitats that can easily be damaged and therefore deserve our best effort to protect them. In the case of decaying reefs, which are already damaged, scientists try to make them grow back by using **concrete blocks** or other support structures to create a sort of artificial reef. This means placing on the seabed objects made of different materials on which corals can grow, near corals that are still healthy. In this way, those polyps can colonize these new areas, attaching to the artificial structures and living there. And over time, by reproducing, they form new coral reefs!

These concrete blocks have been placed near a damaged reef—some corals are already growing on them!

be helped at all. Also, over time, the concrete blocks that make up the reefs can crumble and pieces can pollute the sea. Plus, during storm surges, the violence of the waves can break off pieces of the artificial structure, which hit the nearby coral reefs, damaging them. This is why scientists keep **studying to find special materials** for building artificial reefs that are safer for the sea.

WORK IN PROGRESS

Artificial reefs are really useful, and not just for corals. They actually protect the coasts from erosion and offer shelter to fish and other marine organisms. But, unfortunately, there are also **limitations and problems** in using them. For instance, it isn't possible to be completely sure which coral species will colonize them, so those that are most at risk may not

Many different types of corals have grown on this metal net.

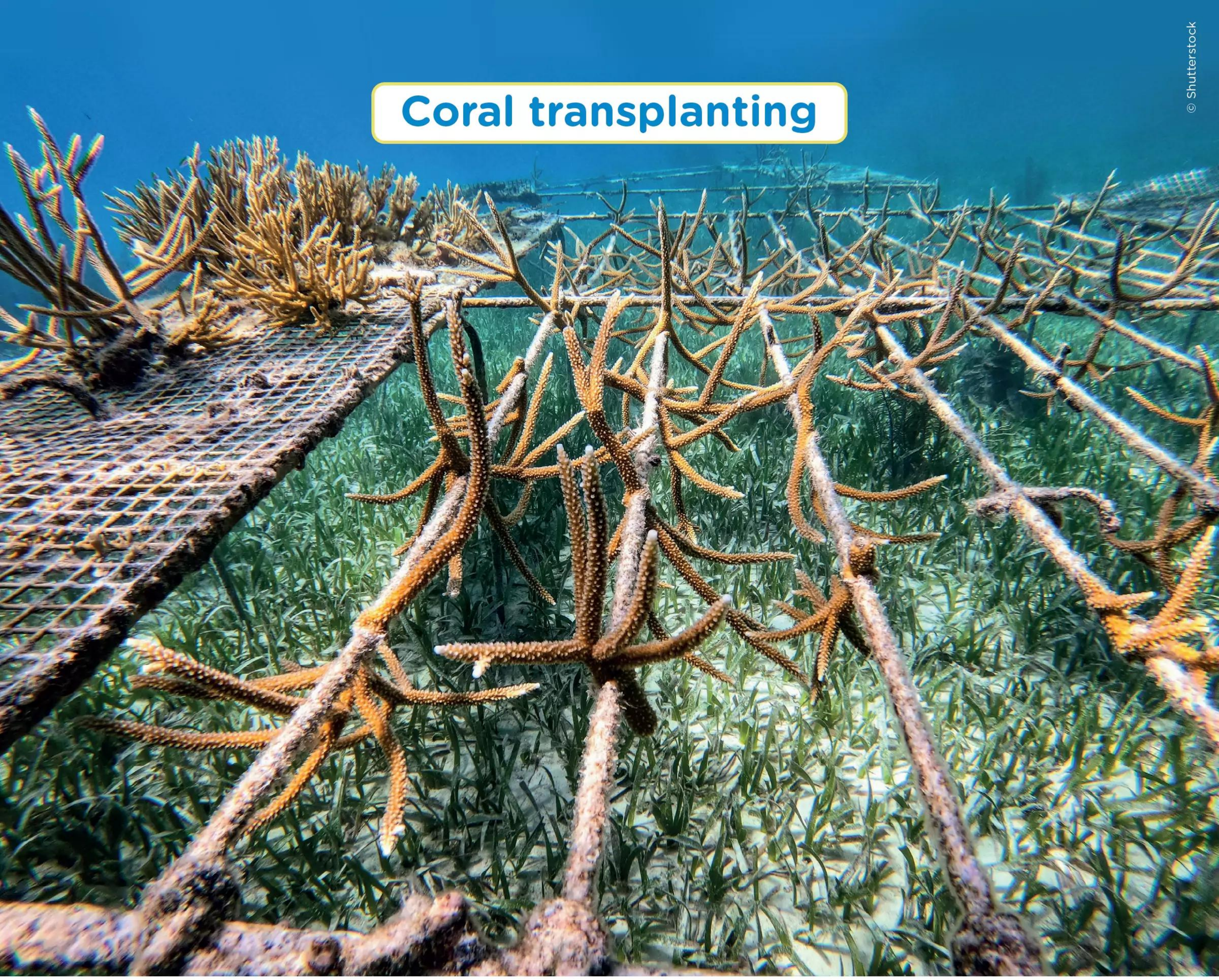
What threatens corals?

THE ENEMIES OF CORALS

In various parts of the world, coral reefs **are bleaching** and the corals themselves are in danger. As we have seen, this happens due to the **increase in temperatur**e, as a result of climate change. Also, **acidification** of the waters creates an unbalanced ecosystem and may represent a threat to corals. And the more these phenomena continue, the worse the situation can get. But even the damage caused by **fishing with nets** and the **extraction of minerals and gases** from the seabed threatens the lives of coral reefs. And with additional damage coming from the spread of alien species, **infectious diseases** that affect polyps, and **storm surges**, it's urgent that humans take immediate action to protect corals!

Corals can also be damaged by careless actions of swimmers and tourists, such as walking on them with flippers or water shoes.

Coral transplanting



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A POSSIBLE SOLUTION

One effective way of repairing coral reefs is **coral transplanting**. Scientists have learned how to breed corals in laboratories and, once grown, transfer them to the sea. There are several ways of doing it.

For example, the planulae bred in labs are released into the sea, where they find a suitable place to transform into corals. Or the planulae are grown in the labs for longer and form **small colonies** of coral in special tanks. The colonies are then transferred to natural or artificial reefs in the sea. Last, corals formed by fragmentation can also be transplanted. This method is called coral gardening. Thanks to these techniques, scientists can choose which coral species to breed, focusing on those at risk.

While transplanting is an important way to help coral reefs, no human intervention can completely heal the damaged reefs, so the only real solution is still **not to destroy them** in the first place.

An example of transplanting *Acropora cervicornis*, or staghorn coral, onto an artificial reef in the sea to rebuild a destroyed reef.

A NEW BEGINNING

Okay. It's time to go!

Yes! I'm super ready!

Let's go before the humans see us!

Bye, Marine Life Institute!

YAY!

SPLISH

SPLASH

SPLOSH

Mr. Ray! We finally know how to save the corals!

MARINE LI

That's fantastic news! Let's go underwater and you can tell me everything!

Tee hee!

ZZZZZZ

Good night, Fluke and Rudder!

We'll take that as a goodbye.

ZZZZZZZ

We're gonna transplant these coral branches close to the bleached corals.

But we gotta go before it's too late!

Where's Bailey?

There were some boats, so he left to avoid being seen.

Oh, okay...

Climb aboard now. We've got a long trip home!

Will we be able to find our way back home without Bailey?

We'll have to.

But after swimming for a while...

Where's the California Current, Mr. Ray?

I'm sorry... I can't find it.

Oh, no! If we don't get home in time...

Our mission will fail.

Wait. Maybe that dolphin can help us!

How?

Uh! Hello, Mr. Dolphin!

Hi, there! Do you need help?

Yes, please. We've got to get back to the Great Barrier Reef. Can you help us find the **California Current**?

You're going the wrong way. Follow me!

And...

The current is strong!

Hank, you don't look very comfortable... You can hardly swim!

SWISH SWOSH

I'm fine.

:Gasp!: I nearly lost it!

It's gonna take years if we can't go faster.

You'd better put the branches on my back.

Okay...

But along the way...

Mr. Ray, stop!

Oh, no!

SWOOSH

Wait! You're not leaving like this!

Got it!

I think you need more help. But I can't catch the EAC with you and take you all the way to Australia!

Maybe you can call our friend Bailey, the beluga. He can carry Hank and the coral branches.

Yeah, that's a good idea.

What's he doing?

He's calling Bailey.

How can Bailey hear him? I'm really close, and I can't hear him.

I'll tell you later, Dory.

He'll be here soon!

Shortly after...

Hey! I'm here!

Bailey!

Phew!

Whoa, he heard the dolphin call!

BYEEEEEE, Mr. Doooolphin!

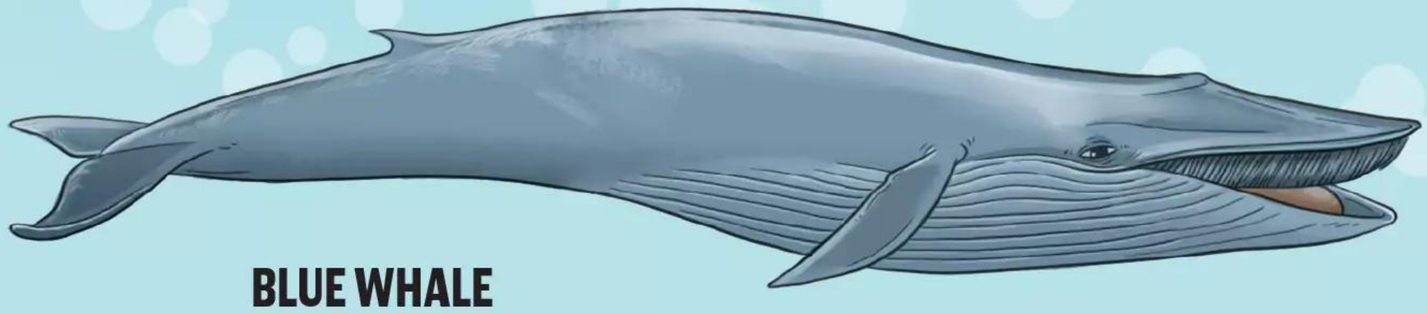
Thank you for helping us!

How did you hear him, Bailey?

Cetaceans can make special sounds that allow them to communicate across the ocean.

Cetaceans?

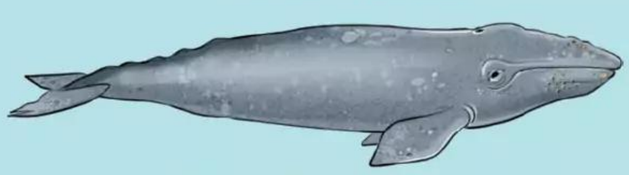
"Cetaceans are marine mammals like Bailey. They live in oceans, seas, and even in a few rivers around the world."



BLUE WHALE

NARWHAL

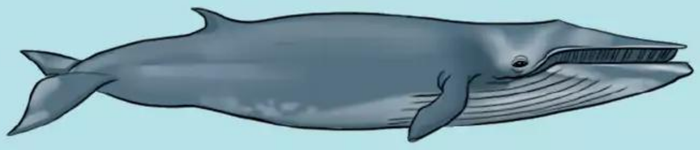
BELUGA



MINKE WHALE

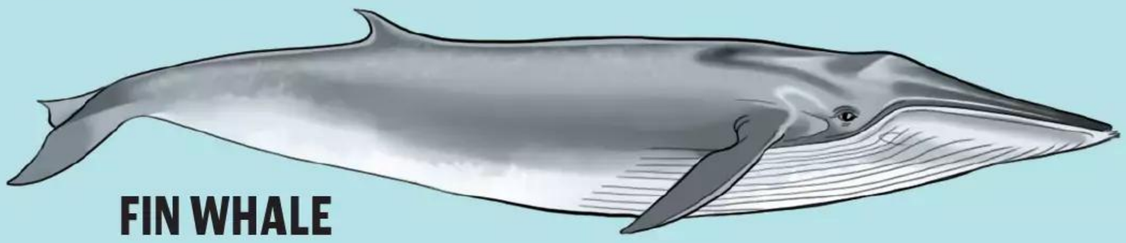
HUMPBACK WHALE

KILLER WHALE

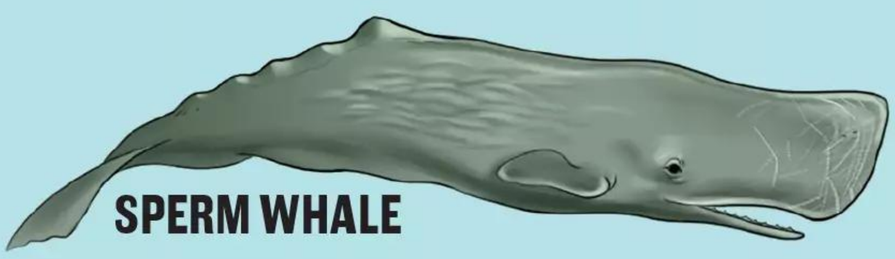


SEI WHALE

DOLPHINS



FIN WHALE



SPERM WHALE

PORPOISE

"There are various types of cetaceans: whales, dolphins, and porpoises."

NORTHERN RIGHT WHALE

BOWHEAD OR ARCTIC WHALE

"Some of them can stay underwater for more than half an hour, but then, unlike us fish, they need to go to the surface for fresh air."

And they all communicate with sounds that travel through the oceans.

Yeaaaah, whaaale sooounds are liiike soooongs!

Exactly, Dory. Whales make sequences of different sounds like **clicks** or **growls**, and their songs have a sort of musical pattern.

THE PATTERN OF A WHALE SONG

Different symbols and colors correspond to different sounds.

They're very powerful and can be heard by other whales from kilometers away.

We are goooing hooOme home hooOme!

To save the cooorals OOHOOHOOH!

Going on a journey is oh so fantastic when the group is all enthusiastic.

And after a long journey...

Welcome back!

At last, dudes!

You're back!

Wow! Hello, everybody!

How did you know we were coming?

Some dolphins came to tell us that you'd found an answer to the corals' problem!

Yep. I communicated with the dolphins and asked them to warn everybody.

What's the fix, dude?

Healthy coral branches. We're gonna plant them next to the bleached corals.

We saw an experiment at the Marine Life Institute. They'll help new, healthy corals grow!

Will it work?

I hope so...

We'll have to wait and see!

And after a few months...

Look! They're getting so... so... colorful!

This is a good start!

Yeah, it is, but there's more the humans can do. Like build that rock wall.

I feel like we've done something good for the corals!

It was scary, but looking at this makes it worth it!

Yeah... that wasn't so bad.

We did this together, and the humans can do even more to help!

Now... about that plastic in the ocean...

Oh, no! I need a rest!

Come on, there's lots to do. Let's go!

THE END

A FREE AND CLEAN OCEAN

- The languages of the sea
- Communicating with sounds
- An ocean of plastic
- Turning the tide!

The languages of the sea

NOISY WATERS

The sea may seem very silent, but it isn't! In fact, lots of crustaceans, fish, and marine mammals produce many **underwater sounds to communicate**, and each species uses different ones, for example, to indicate the boundaries of their territory, choose who to breed with, or take care of their young. Some animals also use sounds to locate their prey while hunting. Some fish produce sounds that reach only short distances, while marine mammals, like whales, can make sounds that travel a long way. Unfortunately, the **noises of motor boats** and other **human activities** are increasing and can **disturb the communication** of marine organisms, thus endangering their lives.

Dolphins use sounds also to orient themselves. With echolocation, they can identify objects the size of a golf ball from 100 meters away.

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Communicating with sounds

STRANGE WAYS OF COMMUNICATING

Some ocean animals have strange ways of communicating, like the anglerfish, which whistles, grunts, croaks, and buzzes in order to defend itself or find a partner. But the noisiest animal in the sea is actually a very small one: the **pistol shrimp**, which is only a few centimeters in size. It has one claw bigger than

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The claw is the pincer-shaped structure at the front of a crustacean's body. *Alpheus angulosus*, the pistol shrimp, has a special claw that produces sounds!

the other, which it opens and closes quickly, forming a bubble of **very hot steam**. When the bubble pops, it makes a loud noise with which the shrimp stuns its prey. Bottlenose dolphins also have an interesting way of communicating underwater. In fact, each animal of the species has its own **unique and recognizable whistle**. And male humpback whales sometimes **sing** for hours when they're looking for a mate.

WHAT IF THEY STOP COMMUNICATING?

The sounds produced by marine organisms are **essential for them to hunt and reproduce**. **Bioacoustics**, the science that studies the sounds animals produce and hear, has become increasingly important in recent years so that we can better understand the damage caused to marine ecosystems by **noise pollution**. This phenomenon can result in the separation of a species from its habitat or make its reproduction more difficult, thus putting the entire ecosystem at risk. So it's important to **"clean" noise pollution from the ocean**, for instance by limiting navigation or using quieter boats.

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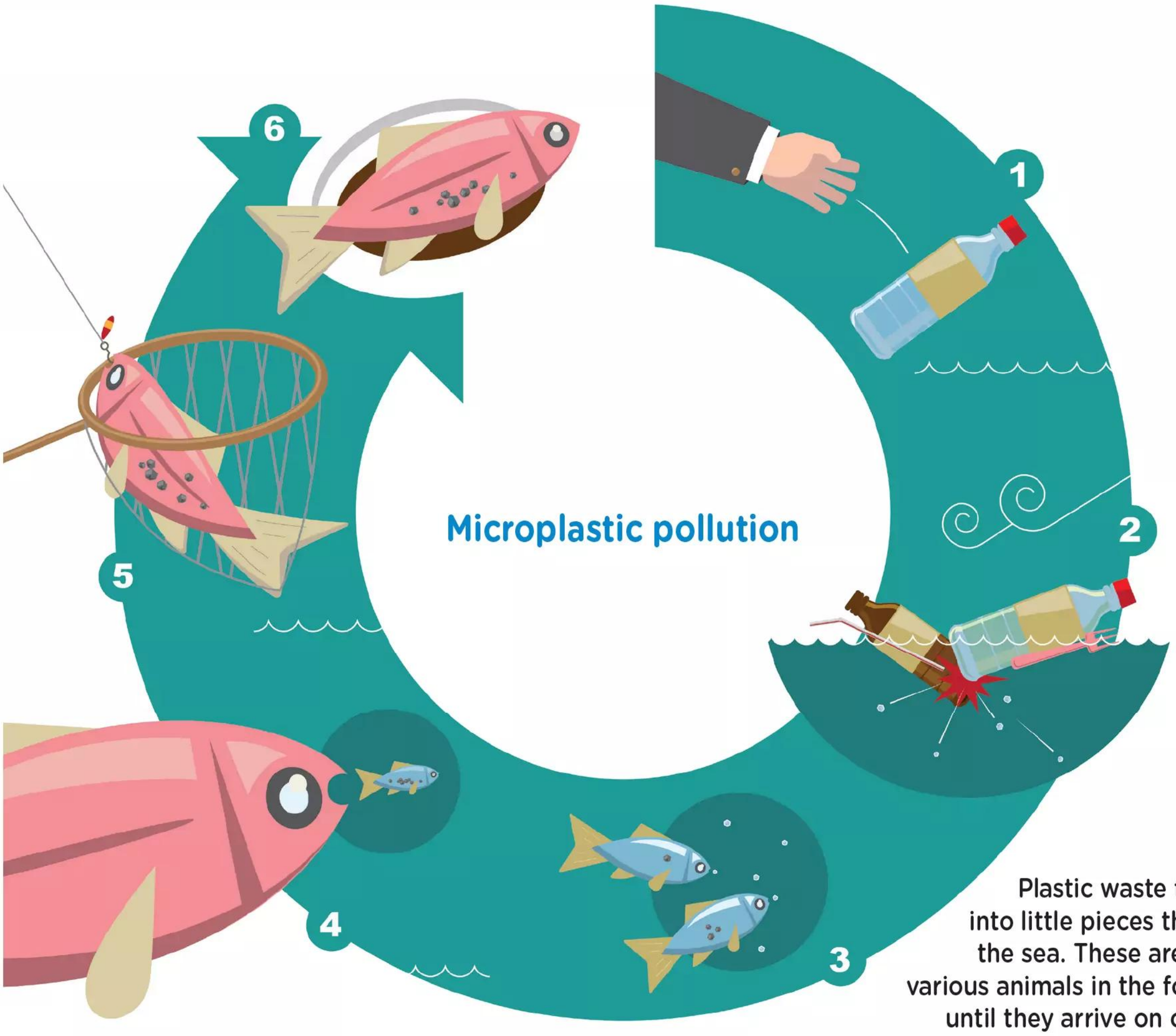
A boat with scientists on board studying the noise pollution produced by a large cruise ship in the Ligurian Sea, northern Italy.

An ocean of plastic

THE DANGERS OF PLASTIC

Another dangerous type of ocean pollution is caused by **plastic waste**. Plastic is a material widely used by humans, and we produce the huge amount of around 300 million tonnes of it every year! But plastic isn't **biodegradable**, meaning it isn't digested by bacteria or other organisms found in nature. So when it ends up in the oceans, it accumulates in patches that get bigger and bigger over time, forming what look like islands of plastic. One of those, the **Great Pacific Garbage Patch** in the Pacific Ocean, is a gigantic pile of waste that is now almost as big as the United States of America. And if things continue like this, by the year 2050 there could be **more plastic in the sea than fish**! But the worst threat to the oceans is microplastics—tiny fragments distributed throughout the water column that are very difficult to eliminate and are swallowed by sea creatures. In this way, they end up in ecosystems' food chains. Microplastics also work as "magnets" capturing and absorbing other pollutants present in the sea, such as metals, which therefore enter the food chain along with them. So they're even more harmful, not only for marine animals but also for humans consuming seafood.



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Plastic waste fragments into little pieces throughout the sea. These are eaten by various animals in the food chain, until they arrive on our plates.

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Turning the tide!

A sustainable future for humanity on planet Earth depends on clean and healthy oceans. Human beings must protect them!

A COMMITMENT TO KEEP

Polluting human activities and the excessive exploitation of resources have already caused a lot of damage to the oceans. And continuing this way could put ecosystems, especially the most delicate ones, in extremely **serious danger**. Luckily, the governments in many countries around the world are helping fight against pollution, for instance by encouraging the **reuse and recycling** of materials, including plastics, or limiting their use. Scientists are also working hard to **develop less-polluting alternatives**, such as materials and new fabrics made with plant fibers or sugars. But the best way of protecting the ocean and its inhabitants is to take care of them from the beginning. This is why it's important we humans learn to **consider the impact of everything we do** that might cause changes to habitats and the natural balance. Moreover, thanks to the safeguarding work of marine scientists and the creation of protected areas, it's possible to limit the damage and prevent things from getting worse, and buy us **some more time to save the oceans** and all the extraordinary creatures that live there.

CHECK ARENA

Now that you've read the comics, test your knowledge with some science questions! Are you ready?

Challenge yourself and your friends! Score **a point for each correct answer** and let the marine expert in you win!

1

The aphotic zone is the area of an ocean where there's very little or no sunlight.

○ TRUE ○ FALSE

2

Shells are mainly made of a mineral called carbon dioxide.

○ TRUE ○ FALSE

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3

Sandy shores are the perfect habitat for sole (the fish).

○ TRUE ○ FALSE

4

Coral bleaching is a normal step in the coral life cycle.

○ TRUE ○ FALSE

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5

The East Australian Current is the largest ocean current close to Australia.

○ TRUE ○ FALSE

6 When water gets too warm, sea urchins proliferate and eat seagrass meadows, destroying them.

○ TRUE ○ FALSE

7 If the sea level gets higher, the water may cover low-lying rocks and flat islands.

○ TRUE ○ FALSE

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8 Microplastics are very small and non-polluting fragments of plastic that are easily biodegradable in the sea.

○ TRUE ○ FALSE

9 Coral transplanting is a possible solution to coral bleaching and damaged reefs.

○ TRUE ○ FALSE

10 Cetaceans are fish that live in oceans, seas, and a few rivers.

○ TRUE ○ FALSE

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YOUR SCORE

Check the answers at the bottom of the page and add up your score.

Less than 5 correct answers
Maybe you missed a few passages, but . . . you're lucky: comics are fun—especially when they're about Nemo, Dory, and friends. Read the stories again, and next time you'll really score for sure!

More than 5 correct answers
Congrats! You know a lot about oceans! You'd be an amazing marine biologist. You can start by doing your best to preserve the ocean environment.

Answers and solutions: **1. True.** SOLUTION: Go to page 12, **2. False.** SOLUTION: Go to page 30, **3. True.** SOLUTION: Go to page 42, **4. False.** SOLUTION: Go to page 56, **5. True.** SOLUTION: Go to page 65, **6. True.** SOLUTION: Go to page 83, **7. True.** SOLUTION: Go to page 94, **8. False.** SOLUTION: Go to pages 72 and 139, **9. True.** SOLUTION: Go to page 153, **10. False.** SOLUTION: Go to page 167.